QQ-S-631A
June 15, 1971
SUPERSEDING
Fed. Spec. QQ-S-631
August 24, 1965

FEDERAL SPECIFICATION

STEEL, BAR, CARBON, HOT ROLLED, (SPECIAL QUALITY)

This specification was approved by the Commissioner, Federal Supply Service, General Services Administration, for the use of all Federal agencies.

1. SCOPE AND CLASSIFICATION

1.1 Scope. This specification covers special quality hot rolled carbon steel bars for general fabrication purposes (see 6.1). It does not cover the free machining or leaded carbon steel hot rolled bars (see 6.4).

1.2 Classification.

1.2.1 Descriptive requirements.

1.2.1.1 Chemical composition. Special quality carbon steel bars are furnished to chemical composition in accordance with the steel grade numbers and compositions of Fed. Std. No. 66 or to minimums, maximums, and ranges in accordance with Fed. Std. No. 66 (see 6.3). Compositions for phosphorus and sulphur for bars ordered to mechanical property are shown in table I.

1.2.1.2 Mechanical properties. Special quality carbon steel bars are furnished to mechanical properties with limits on chemical composition for phosphorus and sulphur. Mechanical properties shall be specified in accordance with class numbers shown in table II or table IV (see 3.2 and 3.4).

1.2.2 Additional descriptive requirement. Austenite grain size (see 3.3).

1.2.3 Condition. Special quality steel bars are furnished in the as rolled condition (AR) or in the following additional thermal treatments as specified (see 3.4.1).

Annealed (A)
Normalized (N)
Normalized and tempered (NT)
Quenched and tempered (QT)
Stress relieved (SR)

1.2.4 Forms. Special quality steel bars are furnished in the following forms, as specified (see 6.2).

Rounds	Hexagons
Half rounds	Ovals (blunt and sharp)
Squares	Half ovals
Round-cornered squares	Bar size shapes
Flats	Special bar sections

1.2.5 Size. Special quality steel bars are furnished in the following size ranges, as specified (see 6.2).

Rounds	1/4 to 10 inches, incl.
Square cornered squares	1/4 to 6 inches, incl.
Round cornered squares	3/8 to 8 inches, incl.
Hexagons	3/8 to 4-1/16 inches, incl.
Flats	Over 0.203 inch in specified thickness, and specified width up to 8 inches, incl.
Ovals, half ovals, half rounds	Consult producer for sizes available
Special bar sizes	Consult producer

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issues in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

Federal Specification:

H-B-621 - Brush, Stencil.

Federal Standards:

Fed. Std. No. 48 - Tolerances for Steel and Iron Wrought Products.
Fed. Std. No. 66 - Steel: Chemical Composition and Hardenability.
Fed. Std. No. 123 - Marking for Domestic Shipment (Civil Agencies).
Fed. Test Method Std. No. 151 - Metals: Test Methods.

(Activities outside the Federal Government may obtain copies of Federal Specifications, Standards, and Handbooks as outlined under General Information in the Index of Federal Specifications and Standards and at the prices indicated in the Index. The Index, which includes cumulative monthly supplements as issued, is for sale on a subscription basis by the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402.

(Single copies of this specification and other Federal specifications required by activities outside the Federal Government for bidding purposes are available without charge from Business Service Centers at the General Services Administration Regional Offices in Boston, New York, Washington, DC, Atlanta, Chicago, Kansas City, MO, Fort Worth, Denver, San Francisco, Los Angeles, and Seattle, WA.

(Federal Government activities may obtain copies of Federal Specifications, Standards, and Handbooks and the Index of Federal Specifications and Standards from established distribution points in their agencies.)

Military Standards:

MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-163 - Steel Mill Products Preparation for Shipment and Storage.

(Copies of Military Specifications and Standards required by contractors in connection with specification procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless a specific issue is identified, the issue in effect on date of invitation for bids or request for proposal shall apply.

American Society for Testing and Materials (ASTM) Standards:

E 8 - Tension Testing of Metallic Materials
E 10 - Brinell Hardness of Metallic Materials
E 18 - Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
E 112 - Estimating Average Grain Size of Metals
E 290 - Semi-Guided Bend Test for Ductility of Metallic Materials

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

National Motor Freight Traffic Association, Inc., Agent:

National Motor Freight Classification.

(Application for copies shall be addressed to the National Motor Freight Traffic Association, Inc., Agent, 1616 P Street, N. W., Washington, D. C. 20036.

Uniform Classification Committee, Agent:

Uniform Freight Classification.

(Application for copies should be addressed to the Uniform Classification Committee, Tariff Publishing Officer, Room 202 Union Station, 516 W. Jackson Boulevard, Chicago, Illinois 60606.)

3. REQUIREMENTS

3.1 Chemical composition.

3.1.1 When special quality bars are ordered to chemical composition only, the bars may be ordered to identification grade numbers (see 6.3), or applicable ranges or maximum or minimum limits (see 6.3). A ladle analysis of each heat of steel shall be furnished by the supplier (see 6.2).

3.1.2 When special quality bars are ordered to chemical composition and mechanical properties, the supplier shall furnish a ladle analysis. The phosphorous and sulphur shall conform to table I for each heat of steel (see 6.2).

TABLE I. Phosphorus and sulphur limits when mechanical property requirements are specified[1/]

	Ladle limits of range, percent	
	Phos.	Sul.
Open hearth	0.04 max.	0.05 max.
Acid bessemer	.07/.12	.06 max

1/ A range in carbon shall not be specified with mechanical property requirements.

3.1.3 Check analysis. The chemical composition, as determined by check analysis, shall meet the requirements for the specified ladle chemical composition subject to the check analysis requirements and applicable tolerances in Fed. Std. No. 66.

3.2 Mechanical properties. When special quality bars in the as rolled condition are specified to chemical composition and mechanical properties, the test specimens representing the bars shall meet the requirements as shown in table II for the class specified. **When special quality bars in the as rolled condition are specified to mechanical and bend properties, the test specimens for mechanical properties shall meet the requirements of table II for the class specified and the bend specimens shall meet the requirements of table III for the class specified.**

TABLE II. Mechanical property requirements[5/]

Class[1/]	Tensile strength p.s.i. range	Yield point min. p.s.i.	Elongation, min. percent	
			8 inch gage[2/,3/]	2 inch gage[4/]
45	45000-55000	22500	27	33
50	50000-60000	25000	25	30
55	55000-65000	27500	23	26
60	60000-72000	30000	21	22
65	65000-77000	32500	17	20
70	70000-85000	35000	14	18
75	75000-90000	37500	14	18
80	80000	40000	13	17

[1/] These tensile requirements do not apply to bars (except flats) less than 1/2 inch in thickness or diameter or to bar size shapes less than 1 square inch in cross section; however, chemistry shall be applied that is consistent with the mechanical properties desired.

[2/] For material under 5/16 inch in thickness or diameter deduct 2.0 percent for each 1/32 inch under 5/16 inch.

[3/] For material over 3/4 inch in thickness or diameter deduct 0.25 percent for each 1/32 inch over 3/4 inch, but not to exceed a total deduction of 3.0 percent.

[4/] For material over 2 inches in thickness or diameter deduct 1.0 percent for each inch (or fraction thereof) over 2 inches, but not to exceed a total deduction of 3 percent.

[5/] Tensile strength over 80,000 p.s.i. min. and 95,000 p.s.i. max. may be negotiated. Restricted tensile range, yield-tensile ratio or ductility, when required as other than given in this table shall be negotiated.

3.3 Austenite grain size. When specified in the contract or order, special quality killed steel bars may be specified to coarse (1-5, inclusive) or fine (5-8, inclusive) grain size. Unless otherwise specified, at least 70 percent of the grains shall comply with the ordered size.

TABLE III. Bend test requirements - Ratio of bend diameter to thickness of specimen[1/] for thickness or diameter of bar, inches[2/]

Class	3/4 & under	Over 3/4 to 1 incl.	Over 1 to 1-1/2 incl.	Over 1-1/2 to 2 incl.	Over 2 to 3 incl.	Over 3 to 5	Over 5
45	Flat	Flat	1/2	1	1	2	3
50	Flat	1/2	1	1-1/2	2-1/2	3	3-1/2
55	1/2	1	1-1/2	2	2-1/2	3	3-1/2
60	1/2	1	1-1/2	2-1/2	3	3-1/2	4
65	1	1-1/2	2	3	3-1/2	4	5
70	1-1/2	2	2-1/2	3	3-1/2	4	5
75	2	2	3	3-1/2	4	4-1/2	6
80	2	2-1/2	3	3-1/2	4	4-1/2	6

1/ Bend test specimens shall be bent 180° at room temperature.

2/ When machined specimens are used on sizes over 1-1/2" in thickness or diameter, the ratio of bend diameter to thickness of the bend test specimen shall be increased by 50 percent.

3.4 Condition. Unless otherwise specified in the contract or order, special quality bars shall be furnished in the as rolled (AR) condition (see 1.2).

3.4.1 Additional thermal treatments. When specified in the contract or order special quality bars may be specified to the following thermal treatments to meet requirements for hardness or mechanical properties.

a. Annealed - ordinary, spheroidize, lamellar pearlitic. Bars may be specified to any one of these annealing treatments to a maximum hardness. Maximum hardness is dependent on end use and shall be as specified on the drawing, in the contract or order, or as agreed between the procuring activity and the contractor.

b. Normalized. Bars may be specified to a maximum hardness after the normalizing treatment. Maximum hardness shall be as specified on the drawing, in the contract or order, or as agreed between the procuring activity and the contractor.

c. Quenched and tempered. Bars may be specified to a hardness range or to mechanical properties. The hardness range shall be as specified on the drawings, in the contract or order, or as agreed between the procuring activity and the contractor. The hardness range specified shall be not less than 0.3 millimeter Brinell impression diameter at an identified test location. Mechanical properties shall meet the requirements as shown in table IV for the size specified or as agreed upon between the procuring activity and the contractor.

d. Stress relieved. Bars may be specified to a maximum hardness. The maximum hardness shall be as specified on the drawings, in the contract or order, or as agreed between the procuring activity and the contractor.

TABLE IV. Tensile requirements, quenched and tempered condition

Diameter or distance between parallel faces, in.	Yield point min., p.s.i.	Tensile strength min., p.s.i.	Elongation in 2 in., min. percent	Reduction of area, min. percent
1 and under	75000	110000	18	45
Over 1 to 2-1/2 incl.	70000	105000	18	45
Over 2-1/2 to 4, incl.	65000	95000	18	45
Over 4 to 6, incl.	60000	90000	18	40
Over 6 to 9-1/2, incl.	50000	85000	18	35

3.5 Finish. Unless otherwise specified in the contract or order, bars shall be furnished with an as-rolled finish. When specified, steel bars shall be furnished descaled or descaled and coated.

3.6 Dimensions. Dimensions shall be as specified in the contract or order, or on the applicable drawing (see 1.2.5 and 6.2). Unless otherwise specified, dimensional tolerances from specified size shall be in accordance with Fed. Std. No. 48 as shown in the applicable tables for hot rolled carbon steel bars (tables 1a 1 through 1a 12).

3.7 Identification marking. Bars shall be marked for identification as specified in the contract or order. For Defense Supply Agency procurement, bars shall be continuously marked as follows:

a. All bars 1/2 inch or more in width of flat or diameter shall be marked at intervals not greater than 3 feet throughout length of bar with specification number, grade, heat number, and contractor's name or trademark. The surface to be marked shall be clean, dry, and entirely free of oil, grease, and other substances that may adversely affect the adhesive quality of the marking inks. After marking, sufficient drying time shall be allowed to prevent smearing. The marking shall not rub off or be smeared by contact incident to normal handling during shipment or storage.

b. Bars smaller than 1/2 inch in width of flat or diameter shall be bundled and tagged with the specification number, grade, heat number, and contractor's name or trade mark at each end with an extra tag included in the bundle.

3.8 Workmanship. Bars shall be clean and free from pipe, segregation, surface defects, and other defects which may detrimentally affect the suitability of the bars for their intended use.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure that supplies and services conform to prescribed requirements.

4.2 Lot. Unless otherwise specified in the contract or order, a lot shall consist of all bars submitted for inspection at the same time of the same heat (of the same batch for thermally treated bars which are batch treated), and of the same size, thickness, or shape.

4.3 Sampling.

4.3.1 For chemical analysis. At least one sample shall be taken from each lot for check analysis.

4.3.2 For mechanical properties. At least two samples for tension testing shall be taken from each lot, except that when the finished material from a lot is less than 30 tons one test sample shall be taken.

4.3.3 For hardness tests. At least two samples for hardness tests shall be taken from each lot.

4.3.4 For austenite grain size. At least one sample from each lot shall be taken for checking austenite grain size.

4.3.5 For bend test. At least two samples shall be taken from each lot for bend testing.

4.4 Examination.

4.4.1 Visual. Unless otherwise specified in the contract or order, bars in each lot shall be subject to examination for compliance with the requirements for finish (see 3.5), identification marking (see 3.7), and workmanship (see 3.8).

4.4.2 Dimensions. Unless otherwise specified in the contract or order, all bars in each lot shall be measured to determine compliance with the dimensional requirements (see 3.6).

4.4.3 Preparation for delivery. Prior to shipment, examination shall be made to determine compliance with the requirements of section 5.

4.5 Tests.

4.5.1 Chemical composition. Samples for check analysis shall be prepared and tested in accordance with method 111 or method 112 of Fed. Test Method Std. No. 151. In case of dispute, analysis by method 111 shall be the basis for acceptance or rejection.

4.5.2 Tension tests. Specimens for tensile testing shall be prepared and tested in accordance with ASTM E 8.

4.5.3 Hardness tests. Specimens for hardness testing shall be prepared and tested in accordance with ASTM E 10 or E 18, as applicable.

4.5.4 Austenite grain size. Specimens for austenite grain size testing shall be prepared and tested in accordance with ASTM E 112.

4.5.5 Bend tests. Samples for bend testing shall be prepared and tested in accordance with ASTM E 290.

4.6 Marking adhesion. A clean, dry brush (conforming to H-B-621, type L) shall be applied (10 strokes) across the markings, using sufficient pressure to bend the bristles 15 to 20 degrees in order to determine proper adherence of marking inks required in 3.7.

4.7 Rejection and retest. Unless otherwise specified in the contract or order, rejection and retest shall be conducted in accordance with the general section of Fed. Test Method Std. No. 151.

5. PREPARATION FOR DELIVERY

5.1 Preservation and packaging. Preservation and packaging shall be level A or C as specified (see 6.2).

5.1.1 Level A. Preservation and packaging shall be in accordance with the applicable requirements of MIL-STD-163.

5.1.2 Level C. Unless otherwise specified, cleaning, drying, preservation, and packaging shall be in accordance with the manufacturer's standard practice, providing it insures protection for the product during shipment and safe delivery to its destination.

5.2 Packing. Bars shall be packed for shipment in accordance with levels A or C as specified (see 6.2).

5.2.1 Level A. Bars shall be packed in accordance with the applicable requirements of MIL-STD-163.

5.2.2 Level C. Packing shall be in accordance with commercial practice adequate to insure acceptance and delivery by the carrier for the mode of transportation employed. Containers shall comply with the requirements of the Uniform Freight Classification or National Motor Freight Classification, as applicable to the mode of transportation.

5.3 Marking.

5.3.1 Civil agencies. In addition to any special marking specified in the contract or order, marking for shipment shall be in accordance with Fed. Std. No. 123.

5.3.2 Military activities. In addition to any special marking specified in the contract or order, marking for shipment shall be in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. Special quality carbon steel bars are produced for applications involving forging, heat treating, cold drawing, machining, etc.

6.2 Ordering data. Purchasers should select the preferred options permitted herein and include the following information in procurement documents:

a. Title, number, and date of this specification.
b. Chemical composition or mechanical property requirements (see 1.2.1, 3.1, and 3.2).
c. Condition if other than as rolled is required (see 1.2.3 and 3.4)
d. Austenite grain size, coarse or fine, if required (see 1.2.2 and 3.3).
e. Maximum hardness or mechanical properties if condition other than as rolled is required (see 3.4.1).
f. Finish if other than as rolled is required (see 3.5).
g. Form and size (see 1.2.4 and 1.2.5).
h. Dimensional requirements (see 3.6).
i. Identification marking (see 3.7).
j. Levels of preservation and packing required (see section 5).

6.3 Selection of chemical composition.

6.3.1 Steel grade designations numbers. Designations covering chemical composition (ladle analysis) as covered in Fed. Std. No. 66 commonly produced to this specification are as follows:

1008	1017	1026	1037	1043	1050
1010	1018	1029	1038	1045	1060
1012	1020	1030	1040	1046	1080
1015	1023	1035	1041	1048	1090
1016	1025	1036	1042	1049	1095

6.3.2 Minimum and maximum limits and ranges. When carbon steel in bar form is specified to chemical composition, the compositions are commonly prepared using the ladle ranges and limits shown in table V. For steel manufactured by any process, the elements comprising the desired chemical composition are specified in one of three ways:

a. By a maximum limit.
b. By a minimum limit.
c. By minimum and maximum limits, termed the range.

TABLE V. Hot rolled carbon steels (special quality)

Ladle chemical ranges and limits

Element	Chemical ranges and limits, percent		
	When maximum of specified element is:	Range	Lowest max.
Carbon (see Note 1)	To 0.12 incl.	-	0.06
	Over 0.12 to 0.25 incl.	0.05	
	Over 0.25 to 0.40 incl.	.06	
	Over 0.40 to 0.55 incl.	.07	
	Over 0.55 to 0.80 incl.	.10	
	Over 0.80	.13	
Manganese	To 0.40 incl.	0.15	0.35
	Over 0.40 to 0.50 incl.	.20	
	Over 0.50 to 1.65 incl.	.30	
Phosphorus	Basic steels:		0.04
	To 0.04 incl.		
	Over 0.04 to 0.08 incl.	0.03	
	Over 0.08 to 0.13 incl.	.05	
Sulphur	Basic steels:		
	To 0.05 incl.		0.05
			.06
	Over 0.05 to 0.09 incl.	0.03	
	Over 0.09 to 0.15 incl.	.05	
	Over 0.15 to 0.23 incl.	.07	
	Over 0.23 to 0.35 incl.	.09	
Silicon (see Note 2)	To 0.10 incl.	-	0.10
	Over 0.10 to 0.15 incl.	0.08	
	Over 0.15 to 0.20 incl.	.10	
	Over 0.20 to 0.30 incl.	.15	
	Over 0.30 to 0.60 incl.	.20	
Copper	When copper is required, 0.20 minimum is generally used.		

Note 1: Carbon: The ranges shown in the column headed "Range" apply when the specified maximum limit for manganese does not exceed 1.10 percent. When the maximum manganese limit exceeds 1.10 percent, add 0.01 to the carbon ranges shown above.

Note 2: Silicon: Because of the technological nature of the process, acid bessemer steels are not produced with specified silicon content. It is not common practice to produce a rephosphorized and resulphurized carbon steel to specified limits for silicon because of its adverse affect on machinability.

6.4 Supersession data. QQ-S-631, dated August 24, 1965, supersedes that part of QQ-S-633 covering special quality hot rolled steel bars.

6.4.1 Merchant quality hot rolled steel bars are covered in QQ-S-630 and cold finished steel bars are covered in QQ-S-634. Free machining cold finished bars are covered in QQ-S-637.

6.5 Relationship to commercial standards. Special quality hot rolled steel bars specified to chemistry only are similarly covered in ASTM A 107. Special quality hot rolled steel bars specified to mechanical properties are similar to the documents listed in table VI for the corresponding grades.

TABLE VI. Mechanical property specification

QQ-S-631	ASTM specification	
Class	Designation	Grade
45	A 306	45
45	A 31	A
50	A 306	50
55	A 306	55
60	A 306	60
60	A 7	-
60	A 113	A
65	A 306	65
70	A 306	70
75	A 306	75
80	A 306	80

General requirements for special quality hot rolled steel bars are covered in ASTM A 29.

6.6 International standardization agreement. Hot rolled carbon steel bar classes 1010, 1012, 1015, 1018, 1020, 1025 and 1095 are the subject of internation standardization agreement (ABC-Navy-STD-41, "Interchangeability/ Equivalency of Carbon and Alloy Steels in Bar Form for General Dockyard Repairs").

MILITARY CUSTODIANS:

Army - MR
Navy - SH
Air Force - 11

Review activities:

Army - AT, MI, MU, WC
Navy - AS
Air Force - 84

User activities:

Army - ME
Navy - OS

Preparing activity:
Army - MR

CIVIL AGENCIES INTEREST:

AGR
COM
DC
GSA
HEW

☆ U. S. GOVERNMENT PRINTING OFFICE: 1971-714-159/3103

Orders for this publication are to be placed with the General Services Administration, acting as an agent for the Superintendent of Documents. See section 2 of this specification to obtain extra copies and other documents referenced herein. Price 15 cents each.

SPECIFICATION ANALYSIS SHEET

Form Approved Budget Bureau No. 119-R004

INSTRUCTIONS

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity.

SPECIFICATION QQ-S-631A, Steel, Bar, Carbon, Hot Rolled, Special Quality

ORGANIZATION	CITY AND STATE

CONTRACT NO.	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT
		$

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO IF "YES" IN WHAT WAY?

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity)*	DATE

DD FORM 1 APR 63 1426 REPLACES NAVSHIPS FORM 4863, WHICH IS OBSOLETE